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NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

DECISION THEORY:
INDIVIDUAL BIASES AND THEIR EFFECT ON FORECASTING IN AN ORGANIZATION

by

John Timothy Shannon
and
David Alan Schwiering

December 1983

Thesis Advisor: Philip Bromiley

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Decision Theory: Individual Biases and Their Effect on Forecasting in an Organization

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requirements for the degree of

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I. INDIVIDUAL BIASES IN THE ORGANIZATION

There has been a great deal of research conducted into how individuals go about making decisions and about how biases can enter into the decision making process and effect the outcome of a decision. However, there has not been a great deal written about how these biases effect decisions in an organizational environment. The purpose of this thesis is to examine data provided by two different organizations to see if these biases can be observed in forecasts produced within the organizations. The focus will be centered upon budgetary decisions within firms in both the private and public sectors. The budget was chosen because it is extremely important to the orderly functioning of any organization and, consequently, decisions concerning the budget should be well thought out and thoroughly researched.

There have been cases in which the organizational budgetary development process has been criticized especially in public organizations. Larkey and Smith [Ref. 1] have researched the budgetary problems of a large city government over a thirty-six year period and have found empirically that the majority of the budget problems within that city have been overstated in their severity--understating revenues and overstating expenditures--in such a manner as to absolve those accountable from any responsibility. Larkey and Smith found that in most instances misrepresentation of budgetary problems appeared to have been done not for repugnent reasons, but rather to help protect city officials from themselves in their roles (i.e., to increase the pressure to make fiscally responsible decisions). [Ref. 2]

This thesis is divided into five chapters. Chapter II reviews the applicable literature concerning heuristics as

they pertain to decision theory. Two facets of decision theory normative, and prescriptive, are discussed. In addition the concept of expected utility is presented. Finally commonly occurring heuristic principles that individuals rely upon when faced with decision making are introduced. Chapters III and IV present and analyze the data. Chapter III deals with a large government organization, the Navy Stock Fund, while Chapter IV is about a division within a large private corporation. The process of producing a budget within each organization is discussed very briefly. Finally the relation between the budgets and the forecasts which predict these budgets is examined. The object is to see if any of the heuristic biases discussed in Chapter II can be found in the relations between actual results and the forecasting of those results. If a strong link can be made between the forecast errors and heuristics identified in the literature then individual decision making biases must be of concern in managing organizations. If not, then it would seem that organizational effects have overcome the effects of individual heuristics in forecasting. Chapter V contains a brief review of the findings.

II. HEURISTICS AND DECISION THEORY

A. INTRODUCTION

Most people have had occasion to look back on various decisions affecting their business and personal lives with a mixture of pleasure and regret. In both situations it is usually difficult to determine the real factors which influenced the decisions. While time tends to blur our recollections of details and we may offer what appear to be creditable reasons for our behavior, a searching review often reveals that a decision was not as well considered as it might have been. Frequently our good and bad choices resulted from a combination of random knowledge and a limited understanding of consequences, rather than from a rational choice of possible alternatives. The ability to make good decisions has long been recognized as an attribute necessary for the successful manager; however, no method of ensuring these decisions has yet been developed. In fact, the area of decision theory is being studied by researchers from an increasingly diverse set of disciplines including medicine, economics, education, political science, geography, engineering, marketing, management science, and mathematics, as well as psychology.

Decision theory is concerned with the problems of choice. Older forms of the theory were primarily philosophical and concerned with how man and organizations should choose to achieve their objectives. These were normative theories and offered recommendations and guides on decision making. Later, descriptive theories which were more psychological in nature developed and became concerned with how people or firms actually do make decisions, or with attempts

to predict how a decision maker will actually choose. Combining the two questions of should and how complicated the problem significantly. As stated by Reitzel:

> Practice has assumed that decision-making was something of an art; and as such rested upon the trained experience and judgment of individuals. Decision theory implies that there is a science of decision-making; that just as technological change rests upon a basis of mathematics and the physical sciences, so decision theory rests upon a basis of mathematics and the behavioral sciences. [Ref. 3]

Behavioral decision theory has two interrelated facets, normative and descriptive. The normative theory is concerned with prescribing courses of action that conform most closely to the decision maker's beliefs and values. Describing these beliefs and values and the manner in which individuals incorporate them into their decisions is the aim of descriptive decision theory. The key to understanding any decision-making process is to find the ways in which the decision maker organizes complex and dynamic problems into a workable framework.

Several decades ago a popular approach to teaching people how to make decisions using the concept of expected utility was developed. Leading proponents of this concept viewed expected utility as a prescriptive notion rather than a description of how people actually make decisions. Expected Utility Theory proposed that if an action had a number of possible consequences, the decision maker multiplied the probability of each consequence times the utility of that consequence and then summed over the consequences to decide the expected utility of that action. When faced with alternative actions the decision maker chose the one with the highest expected utility. Since many interesting decisions involve outcomes for which "objective" probabilities cannot be calculated, researchers proposed using guesses of

these probabilities, referred to as subjective probabilities.

Considerable effort has been devoted to studying how people perceive, process, and evaluate the likelihood of the occurrence of uncertain events. Early research on intuitive statistics led Peterson and Beach to the conclusion:

> Man gambles well. He survives and prospers while using fallible information to infer the states of his uncertain environment and to predict future events. Experiments that have compared human inferences with those of statistical man show that the normative model provides a good first approximation for a psychological theory of inference. Inferences made by subjects are influenced by appropriate variables in appropriate directions. [Ref. 4]

One result of this high regard for our intellectual capability has been a reliance on normative models in descriptive research. Barclay et. al. proposed beginning with a normative model and adjusting its form or parameters to produce a descriptive model. This approach is best exemplified by the study of conservatism; the tendency, when evaluating uncertain information, to predict future outcomes that are very close to what actually happened the last time, using new information in a statistically incorrect manner. [Ref. 5]

More recent studies have shown, however, that conservatism occurs only in certain kinds of inference tasks. In a variety of other settings, people's inferences are too extreme, leading to skepticism about the normative model's ability to fulfill its descriptive role. The belief that humans are good intuitive statisticians began to lose favor as pointed out by Carroll et. al.:

> People systematically violate the principles of rational decision making when judging probabilities, making predictions or otherwise attempting to cope with probabilistic tasks. [Ref. 6]

B. HEURISTICS AND BIASES

Recent research suggests that the decision process used by the decision maker is fundamentally different from the normative model. Some of the research on judgmental processes attempts to evaluate man's ability to assess subjective probabilities, that is probabilities which are assigned by individuals based upon their "best guess" in contrast to "objective probabilities" wherein data on previous events are systematically analyzed.

Hogarth argues that man is a selective, sequential information processor with limited capacity and that he is, therefore, ill-suited for assessing probability distributions. Hogarth concludes that because assessing these distributions places specific demands on man's judgmental processes, it is necessary to understand the capabilities and limitations of these processes and how they are affected by characteristics of the judgmental task. [Ref. 7] Tversky and Kahneman argue that people rely on a limited number of heuristic principles that reduce the complex tasks of assessing subjective probabilities and predicting values to simpler judgmental operations. They identify three such principles a human judge might use: (1) "representativeness"-- the degree to which an event is judged similar in essential characteristics to its parent population and judged to reflect the salient features of the process by which it is generated; (2) "availability"-- the ease with which relevant instances or examples or plausible occurrences can be brought to mind; and (3) "anchoring and adjustment"-- the process of adjusting from initial values to yield new final estimates. Tversky and Kahneman conclude that even though these heuristic principles are quite useful, they can lead to serious and systematic errors because they are not influenced by factors that should affect judgments of subjective probability. [Ref. 8]

1. Representativeness

The representativeness heuristic suggests that one way people evaluate the subjective probability of an event, or a sample, is by the degree to which it is judged similar in essential properties to the group from which it was selected. In many situations, a person will judge the probability that object A belongs to class B, or that event A originates from process B, or that process B will generate event A on the basis of the degree to which A is representative of, or resembles, B. When A is judged highly representative of B, the probability that A originates from B is judged to be high. When A is judged not highly representative of B, the probability that A originates from B is judged to be low. [Ref. 9]

This approach, where class membership of an object is judged by its similarity to the stereotypical class member, leads to several systematic biases in probability estimation. [Ref. 10] To test the hypothesis that intuitive predictions may be affected by representativeness and, consequently, be relatively insensitive to prior probabilities, Kahneman and Tversky presented 171 subjects with brief personality descriptions of several individuals, sampled at random from a group of 100 professional engineers and lawyers. The subjects were asked to assess, for each description, the probability that it belonged to an engineer rather than to a lawyer. In one experimental condition, subjects were told that the group from which the descriptions had been drawn consisted of seventy engineers and thirty lawyers. In another condition, subjects were told that the group consisted of thirty engineers and seventy lawyers.

The results revealed that in the absence of a personality sketch, the subjects judged the probability that

an unknown individual was an engineer to be the same as the proportion of engineers in the population -- 70 and 30 percent respectively in the two conditions. However, prior probabilities (i.e., the known proportion of engineers in the population) were totally ignored when a character description was introduced, even when the description was totally uninformative. The odds that any particular description belonged to an engineer rather than to a lawyer should have been higher in the first condition, where there was a majority of engineers, than in the second condition, where there was a majority of lawyers. Yet, the subjects in both conditions produced essentially the same probability judgments. Apparently, the subjects evaluated the likelihood that a particular description belonged to an engineer rather than to a lawyer by the degree to which this description was representative of the two stereotypes, with little or no regard for the prior probabilities of the categories. [Ref. 11]

Another factor that should have an effect on judgments of subjective probabilities, but that may have no effect on representativeness, is sample size. The similarity of a sample statistic to a population parameter does not depend on the size of the sample. Consequently, if probabilities are assessed by representativeness, the judged probability of a sample statistic will be essentially independent of sample size.

Kahneman and Tversky found that subjects failed to appreciate the role of sample size in making judgments of subjective probability, even when it was emphasized in the formulation of the problem. They presented ninety-seven subjects with three problems each of which defined a sampling process with a specified mean and a critical value above the mean. Subjects were asked to judge whether a particular sample outcome was more likely to occur in a

small sample, in a large sample, or about the same in both. Half of the subjects were given outcomes that were more extreme than the specified critical value; the remaining subjects were given outcomes that were less extreme than the specified critical value. Tversky and Kahneman found that most of the subjects judged the probability of obtaining outcomes that were either more or less extreme than the specified critical values to be about the same in small and large samples, presumably because these events were described by the same statistic and were, therefore, equally representative of the general population. Sampling theory suggests that an outcome that is more extreme than the specified critical value is more likely in a small sample than a large one, because a large sample is less likely to stray from the specified mean. However, they concluded that this fundamental notion of statistics was "evidently not part of the subject's repertoire of intuitions." [Ref. 12]

Another factor that should have a major effect on judgments of subjective probability is the presence of correlated input variables. The statistics of correlation assert that, given input variables of stated validity, a prediction based on several input variables will achieve higher accuracy when these variables are independent of each other than when they are correlated. Yet, even though correlation among input variables tends to decrease the accuracy of the predictions, Kahneman and Tversky suggest that it tends to increase the confidence people have in the resulting predictions. They suggest that internal consistency of a pattern of input variables tends to be a major determinant of one's confidence in predictions based on these variables. They also suggest that highly consistent patterns are most often observed when the input variables are highly correlated, and consequently, people will tend to have greater confidence in predictions based on correlated input variables. [Ref. 13]

Their conclusions were based in part on an experiment in which they asked subjects to predict grade-point average on the basis of two pairs of aptitude tests. Subjects were told that one pair of tests was highly correlated, while the other pair of tests was not correlated. For half of the subjects, the labels of the correlated and the uncorrelated pairs of tests were reversed. Subjects were also told that "all tests were found equally successful in predicting college performance." The results revealed that subjects were more confident in predicting from the correlated tests, over the entire range of predicted scores; that is, they were more confident in a context of inferior predictive validity. [Ref. 14]

Tversky and Kahneman refer to the unwarranted confidence that is produced by a good fit between the predicted outcome and the input information as the "illusion of validity." They suggest that this illusion persists even when people are aware of the factors that limit the accuracy of their predictions. [Ref. 15]

A fundamental idea underlying probability theory is that the prior probabilities that summarize what is known about a problem before receiving specific, individuating evidence continue to be relevant even after such evidence has been obtained. Specifically, Bayes' rule provides for a multiplicative relation between prior odds and the odds with new information. Kahneman and Tversky concluded that their subjects failed to integrate prior probabilities with specific evidence and that this failure was one of the most significant departures of intuition from the normative Bayesian approach. [Ref. 16]

2. Availability

There are situations in which people assess the frequency of a class or the probability of an event by the

ease with which instances or occurrences can be brought to mind. This judgmental heuristic is called availability. [Ref. 17]

In life, instances of frequent events are typically easier to recall than instances of less frequent events, and likely occurrences are usually easier to imagine than unlikely ones. Thus availability is often a valid cue for the assessment of frequency and probability. However, since availability is also affected by subtle factors unrelated to likelihood, such as familiarity, recency, and emotional saliency, reliance on it may result in systematic biases.

If examples are brought to mind quickly, it can be assumed that there must be a lot of them, or that if an association is easily made, then it must be accurate, since associative bonds are built with experience. Furthermore, it is ease of retrieval, construction, and association that provides the estimate of frequency or probability, not the sum total of examples or associations that come to mind. Thus, one important difference between the use of the availability heuristic and the use of some more elaborate inferential process is that little actual retrieval or construction need be completed; an estimate of the ease with which this process would be performed is sufficient as a basis for inference. [Ref. 18]

To some extent the assumptions regarding the relationship between ease of construction or retrieval and numbers of examples or associations are accurate, and to the extent that they are, an individual using the availability heuristic will reach correct inferences or at least inferences that match those reached by using more exhaustive procedures. Under other circumstances, however, those inferences may not be accurate because there are biases in the available data that are brought to bear on the problem.

When the size of a class is judged by the availability of its instances, a class whose instances are easily retrieved will appear more numerous than a class of equal frequency whose instances are less retrievable. In an elementary demonstration of this effect, subjects heard a list of well-known personalities of both sexes and were subsequently asked to judge whether the list contained more names of men than of women. Different lists were presented to different groups of subjects. In some of the lists the men were relatively more famous than the women, and in others the women were relatively more famous than the men. In each of the lists, the subjects erroneously judged that the class that had the more famous personalitites was the more numerous. [Ref. 19]

In addition to familiarity, there are other factors, such as salience, which affect the retrievability of instances. The impact of seeing a house burning on the subjective probability of such accidents is probably greater than the impact of reading about a fire in the local paper. Furthermore, recent occurrences are likely to be relatively more available than earlier occurrences. It is a common experience that the subjective probability of traffic accidents rises temporarily when one sees a car overturned by the side of the road. [Ref. 20]

Sometimes one has to assess the frequency of a class whose instances are not stored in memory but can be generated according to a given rule. In such situations, one typically generates several instances and evaluates frequency or probability by the ease with which the relevant instances can be constructed. However, the ease of constructing instances does not always reflect their actual frequency, and this mode of evaluation is prone to biases. [Ref. 21]

Imaginability also plays an important role in the evaluation of probabilities in real-life situations. The risk involved in an adventurous expedition, for example, is evaluated by imagining contingencies with which the expedition is not equipped to cope. If many such difficulties are vividly portrayed, the expedition can be made to appear exceedingly dangerous, although the ease with which disasters are imagined need not reflect their actual likelihood. Conversely, the risk involved in an undertaking may be grossly underestimated if some possible dangers are either difficult to conceive of, or simply do not come to mind. [Ref. 22]

Experience has taught us that, in general, instances of large classes are recalled better and faster than instances of less frequent classes; that likely occurrences are easier to imagine than unlikely ones; and that the associative connections between events are strengthened when the events frequently co-occur. As a result, man uses the availability heuristic for estimating the frequency of a class, the likelihood of an event, or the frequency of co-occurrences, by the ease with which the relevant mental operations of retrieval, construction, or association can be performed. Under some circumstances, use of the availability heuristic leads to perfectly appropriate conclusions; however, under those circumstances where there is a bias in what information is available, faulty inferences follow.

3. Anchoring and Adjustment

Another error-prone heuristic is anchoring and adjustment. With this process, a natural starting point or anchor is used as a first approximation to the judgment. The initial value, or starting point, may be suggested by the formulation of the problem, may be based on historical

data, or may be the result of a partial computation. In any case, adjustments are typically insufficient in that they fall short of the actual final answer. Different starting points yield different estimates, which are biased toward the initial values. [Ref. 23]

In a demonstration of the anchoring effect, subjects were asked to estimate various quantities, stated in percentages. For each quantity, a number between 0 and 100 was determined by spinning a wheel of fortune in the subjects' presence. The subjects were instructed to indicate first whether that number was higher or lower than the value of the quantity, and then to estimate the value of the quantity by moving upward or downward from the given number. Different groups were given different numbers for each quantity, and these arbitrary numbers had a marked effect on estimates. For example, the median estimates of the percentage of African countries in the United Nations were 25 and 45 for groups that received 10 and 65, respectively, as starting points. Payoffs for accuracy did not reduce the anchoring effect.

Anchoring occurs not only when the starting point is given to the subject, but also when the subject bases his estimate on the result of some incomplete computation. A study of intuitive numerical estimation illustrates this effect. Two groups of high school students estimated, within 5 seconds, a numerical expression that was written on the blackboard. One group estimated the product

$$8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1$$

while another group estimated the product

$$1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 \times 8$$

To rapidly answer such questions, people may perform a few steps of computation and estimate the product by extrapolation or adjustment. Because adjustments are typically insufficient, this procedure should lead to underestimation. Furthermore, because the result of the first few steps of multiplication (performed from left to right) is higher in the descending sequence than in the ascending sequence, the former expression should be judged larger than the latter. Both predictions were confirmed. The median estimate for the descending sequence was 2250, while the median estimate for the ascending sequence was 512. The correct answer is 40,320. [Ref. 24]

In a study by Bar-Hillel subjects were given the opportunity to bet on one of two events. Three types of events were used: (1) simple events, such as drawing a red marble from a bag containing 50 percent red marbles and 50 percent white marbles; (2) conjunctive events, such as drawing a red marble seven times in succession, with replacement, from a bag containing 90 percent red marbles and 10 percent white marbles; and (3) disjunctive events, such as drawing a red marble at least once in seven successive tries, with replacement, from a bag containing 10 percent red marbles and 90 percent white marbles. In this problem, a significant majority of subjects preferred to bet on the conjunctive event, the probability of which is .48, rather than on the simple event, the probability of which is .50. Subjects also preferred to bet on the simple event rather than on the disjunctive event, which has a probability of .52. Thus, most subjects bet on the less likely event in both comparisons. This pattern of choices illustrates that people tend to overestimate the probability of conjunctive events and to underestimate the probability of disjunctive events. These biases are readily explained as effects of anchoring. [Ref. 25]

Biases in the evaluation of compound events are also significant in the context of planning and forecasting. The successful completion of an undertaking typically has a conjunctive character: for the undertaking to succeed, each of a series of events must occur. Even when each of these events is very likely, the overall probability of success can be quite low if the number of events is large. The general tendency to overestimate the probability of conjunctive events leads to unwarranted optimism in the evaluation of the likelihood that a plan will succeed or that a project will be completed on time. Conversely, disjunctive structures are typically encountered in the evaluation of risks. [Ref. 26]

4. Aspiration Level

A related concept that may effect the direction and magnitude of adjustment from a given starting point is that of aspiration level. The term "level of aspiration" was introduced into the literature in Germany by T. Dembo in 1930. Dembo hypothesized that the presence of a particular level of aspiration determined whether or not people felt satisfied or dissatisfied with themselves after performance of a task. Since that time numerous studies have supported Dembo's contention. Lewin reported that when first exposed to a level of aspiration situation subjects set an initial level of aspiration higher than their previous performance score and tend to keep it positive under most conditions. He also showed that success and failure directly affect the level of aspiration which is raised and lowered in accordance with the attained or unattained level of the preceeding performance. [Ref. 27]

In conjunction with Dembo, Lewin created an aspiration-level model to explain their findings. It included the following propositions:

1. In the steady state, aspiration level exceeds achievement by a small amount.
2. When achievement increases at an increasing rate, aspiration level will exhibit short-run lags behind achievement.
3. When achievement decreases, aspiration level will be above achievement.
4. Over time, aspiration levels tend to adjust to the level of achievement.

These propositions derive from a set of assumptions requiring that current aspiration be an optimistic extrapolation of past achievement and past aspirations. Although such assumptions are sometimes inappropriate, the model seems to be consistent with a wide range of human goal setting behavior. [Ref. 28] .

C. CONCLUSION

Numerous studies have replicated and extended the Kahneman and Tversky studies, and others have independently arrived at similar conclusions. The represetativeness heuristic has received the most attention. Wise and Mockovak and [Ref. 29] and Bar-Hillel [Ref. 30] have documented the importance of similarity structures in probability judgment. Like Kahneman and Tversky, [Ref. 31] Marks and Clarkson, [Ref. 32] and Svenson [Ref. 33] observed that subjects' posterior probabilities were predominantly influenced by the most representative aspect in a sample. Contrary to the normative model, population proportion and sample size were relatively unimportant. Leon and Anderson [Ref. 34] did find an influence of these two characteristics and, as a result, claimed that Kahneman and Tversky's subjects must have misunderstood the task. Ward, however, argued that the conflicting results were most likely due to

differences in the tasks, rather than to misinterpretation of instructions. Hammerton, [Ref. 35] Lyon and Slovic [Ref. 36] have replicated Kahnemen and Tversky's [Ref. 37] finding that subjects neglect population base rates when judging the probability that an individual belongs to a given category. Additional evidence for representativeness comes from studies by Brickman and Pierce, [Ref. 38] Holzworth and Doherty, [Ref. 39] and Lichtenstein, Earle and Slovic. [Ref. 40]

Availability and anchoring have been studied less often. Evidence of availability bias has been found by Slovic, Fishhoff and Lichtenstein. [Ref. 41] Anchoring has been hypothesized to account for the effects of response mode upon bet preferences, and it has been proposed as a method that people use to reduce strain when making rational judgments. Pitz [Ref. 42] gave the anchoring heuristic a key role in his model describing how people create subjective probability distributions for imperfectly known or uncertain quantities.

A heuristic approach to the study of man's ability to assess subjective probabilities differs somewhat from the normative Bayesian approach that underlies most applications of modern decision theory. The normative approach tends to focus on the question "how should people evaluate uncertainty?" Considerable research has concentrated on ascertaining how people's judgments deviate from the Bayesian model. However, the usefulness of the normative approach to the analysis and modeling of subjective probability depends not only on the accuracy of the subjective estimates but also on the extent to which the normative model captures the essential determinants of the judgment process. A heuristic approach tries to focus on these determinants directly by posing the question "how do people evaluate uncertainty?" Heuristics such as representativeness, availability, and

anchoring are probably adopted because they are useful in reducing the complex tasks of assessing probabilities to simpler judgmental operations.

As noted in the introduction behavioral decision theory postulates that personal judgment follows certain patterns. The studies, however, have largely been concerned with individuals. Many important judgments are made in organizational settings where psychological patterns are complicated by organizational pressures. The next two chapters deal with data from two separate organizations in two different environments. The judgmental processes of forecasting future organizational budgets and outcomes are examined to discover if any of the psychological phenomena discussed above can be observed.

III. THE NAVY STOCKFUND

A. BACKGROUND

The Navy Stock Fund exists for the purchase and holding of numerous supply items which are then "sold" to a customer. The Fund is ultimately "paid" remuneration for requisitions supply items through the customer's legislated appropriation[1]

Because of the diversity and tremendous number of products controlled by the Fund, which varies from food to aviation parts to fuel, and because of the enormous size of the Fund (over $6 billion in New Customer orders expected for FY-83) the Stock Fund has been split into eight Budget Projects each of which is headed by a separate Project Manager. Table I lists the Budget Projects which comprise the Navy Stock Fund.

Each Budget Project Manager has the responsibility of building his own budget which is then aggregated by the Navy Supply Systems Command, submitted to the senior levels of the Department of Defense, reviewed by the Office of Management and Budget and ultimately becomes a portion of the overall defense budget which is to be approved by the Congress each September for the upcoming fiscal year. Along with the budget proposals for the next year, managers must also provide forecasts for the subsequent fiscal year. It is upon the relationship between the approved budgets and these forecasts that this analysis is based.

---

[1] The fund isolates particular activities and operations to permit management to better control these activities by treating them as if they were separate entities. For an in depth discussion of federal budget policy and appropriation procedures see Leloup, L. Budgetary Politics Brunswick, Ohio: King's Court Communicatio Inc., 1980

TABLE I

Budget Projects within the Stock Fund

Budget Project	Commodity
14	Ship's Part
15	Special Clearance Account
15	Forms
21	Commissary and Ship's Stores
28	General Supplies
34	Aviation Parts
38	Retail Fuel
81	Depot Level Repairables

B. ANALYTICAL STRUCTURE

The basic analysis focuses on four of the Budget Projects: 14- Ship's Parts, 21- Commissary Stores, 38- Fuels, and 81- Repairables. Each was chosen because it is differs from the others in many respects. Each has its own distinct market within the Navy community, and, consequently, each manager has a unique set of problems involved in forecasting. Within the four Budget Projects four elements of the budget were compared:

1. New Material Orders-- These are orders from a Navy customer for material needed to support Naval operations
2. Obligations-- These are contracts let by the managers of the Stock Fund to contractors for the purchase of goods or services.
3. Disbursements-- These are payments of cash to private suppliers for goods and sevices and generally lag contracts by several months.

4. Inventories-- These are the cash value placed on the material in stock for issue.

Each Budget Project is examined separately and it was expected that different results could be forthcoming from the different projects. Quarterly figures listing current budgets and forecasts for the next year provided the data needed. Theses figures were analyzed to see what patterns, if any, may be present in the budgetary forecasts. The data was taken from annual "Navy Stock Fund Report and Reapportionment Request" for the fiscal years 1981 to 1983 inclusive. The raw data (presented in Appendix A) was converted into ratios for ease of analysis and explanation. The analysis consists of two phases. Firstly, the approved budget for a given year (say year t) is compared to the accompanying forecast for the next year (year t+1). This was done by computing the ratio of Forecast (t+1)/Budget(t) quarter by quarter for the entire three year period. This number was then further adjusted to account for the expected rate of inflation for the year t+1. This was done by multiplying the ratio by an expected inflation index.[2] The results then provide a growth rate corrected for inflation. For example, if the ratio is 1.00 all of the forecasted budget change is the result of inflation alone and no growth is present. If it is over 1.00 "growth" has been forecast. If the ratio is less than 1.00 "shrinkage" has been predicted. This operation has been named Phase I analysis. All Phase I numbers in the subsequent tables are the inflation adjusted ratios of the forecast for next year to the budget for this year.

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[2] Short Term predictions of inflation are listed yearly by OMB and publicized in suppliments ot annual budget reports. The inflation rates used in the ratio model were: FY-81 10.4%; FY-82 7.2%; FY-83 5.6%.

Secondly, Phase II analysis is concerned with an examination of the accuracy of each manager's forecasts. This is accomplished by comparing the old forecast with the subsequent approved budget. That is, the forecast for the budget for year (t) that was prepared in year (t-1) is compared to the actual approved budget for year (t). A ratio of Forecast:Budget is computed. In this instance a ratio of 1.00 reflects 100% accuracy in forecasting by the Project Manager while a result higher than 1.00 indicates a forecast which was higher than the subsequent budget, and a result of less than 1.00 indicates when the old forecast is less than the approved budget. In Phase II, for example, a comparison is made between a forecast for FY-82 dated 15 September 1980 and a budget approved for FY-82 dated 15 September 1981. The analysis concerns itself with a search for patterns in the prediction habits of the different managers. Attempts will be made to bring out any possible biases which may have effected the forecasting process.

1. Budget Project 14- Ships Parts

Budget Project 14 covers the large number of consumable items which are used in the support of ordnance, electronic and other shipboard equipment. The Project Manager is responsible for the procurement and distribution of approximately 300,000 different items.

With the exception of the Obligations category, almost all of the forecasts are larger than the respective budgets over the three year period. The after inflation growth of New Material Orders was forecast to be slight throughout FY-82 but then a jump to 120% of budget was forecast for FY-83. This growth rate then fell back to approximately 110% growth forecast for FY-84. The same kind of trend can be seen within Disbursements where forecasts rose

TABLE II

Budget Project-14 Ratios

FY/ QTR	New Mat. Orders	Oblig.	Disburse.	Invent.
PHASE I				
81-1	1.07	0.85	1.02	1.12
2	0.91	0.83	0.50	1.06
3	1.19	0.82	1.62	1.04
4	0.95	0.86	1.02	1.06
82-1	1.12	0.81	1.27	1.19
2	1.24	0.81	1.27	1.12
3	1.24	0.84	1.27	1.13
4	1.23	0.87	1.27	1.13
83-1	1.16	1.24	1.12	1.24
2	1.10	1.20	1.12	1.22
3	1.19	1.16	1.12	1.20
4	1.10	1.17	1.12	1.19
PHASE II				
82-1	0.91	0.82	0.64	0.75
2	0.73	0.38	0.51	0.72
3	0.94	0.55	1.30	0.72
4	0.78	0.61	0.97	0.74
83-1	1.12	0.54	1.05	1.16
2	1.29	1.23	1.05	1.14
3	1.12	0.85	1.05	1.11
4	1.38	0.85	1.05	1.09

to 127% for FY-83 and consequently fell back to 112% for the next year. Both of these observations might be the outgrowth of a mixture of the heuristic properties of Representativeness and Aspiration Levels.

To bear this postulation out, the Phase II figures must be examined. It is clear that in all four categories the forecasted figures were substantially below the approved budget for FY-82, which simply means that the Project Manager- on 15 September, 1980-predicted a budget for FY-82 which turned out to be only about 85% of the approved FY-82 budget which was granted on 15 September 1981. The question of why this is so may be answered by carefully examining the timing of the forecasts and the environment within which

they were made. In September of 1980 the nation was involved in a presidential election race which, supposedly, was to be one of the closest of recent times. The incumbent, Mr. Carter, was not known for advocating any major growth in Defense spending. His opponent, on the other hand, readily promoted growth in military spending. The forecast of 15 September 1980 was made while Mr. Carter was still firmly in charge of the White House and apparently reflected the Administration's views of consumable parts requirements for the Navy for two years hence. The actual budget approved during the Reagan administration was significantly higher than anticipated during the Carter administration. The budget approved on 15 September 1981 indicates an average increase of 16% over the old forecast in New Material Orders, 41% in Obligations, 15% in Disbursements, and 27% in Inventories. (See Table II, Phase II.)

The aspiration level phenomenon can be clearly seen in the budget forecast for the next year (Table II, Phase I FY-82) as the predicted real growth for New Material Orders for FY-83 was a whopping 21%. The same can be said for Disbursements and Inventories where growth was forecasted to be 27% and 12% respectively after inflation. The aspiration level effect has contributed to the creation of a forecast which predicts considerable growth relative to past forecasts and, as it turns out, to subsequent forecasts as well. This prediction came at a time when the first Reagan budget had been pushed through Congress creating a perception that over the next four years there would be a substantial growth in the number of ships in the U. S. Fleet. This perception was futher fostered when the Administration took steps to reactivate the USS New Jersey and the USS Iowa. Thus, it was a natural outgrowth of such thought to perceive expansion in this Budget Project and to forecast it.

Another indication of aspiration levels at work here is the fact that FY-83 forecasts were high compared to the approved budget for FY-83. (Table II, Phase II, FY-83.) In the case of New Material Orders the forecast overshot the approved budget by 38% in the fourth quarter and experienced an average forecasting error of about 23% over the entire year. Inventories averaged 12.75% high while Disbursements were closer with only a 5.2% average error. The forecasts for the following year reflect these errors as the aspiration level effect seems to have been dampened rather quickly. Forecasted real growth in New Material Orders and Disbursements fell to approximately 12% of the approved budget from their peviously discussed highs. The forecasted levels of Inventories and Obligations actually grew for the next year. (Phase I FY-83.)

For two years, FY-82 and 83, forecasted Obligations were running between 80 and 87% of the approved budget. (Table II, Phase I FY-81, 82.) However, Phase II data from the same period show that these forecasts were well below the actual budget for both years. Acting on this information, it would seem appropriate for a project manager to expect future Obligations to grow in a like manner. Given the manager had just obtained much more than he expected, it can be hypothezed that his aspiration level rose and that he would forecast such growth in the next budget also. This actually happened as the next forecast rose from 17% below budget to 19% above budget. (Phase I, FY-82, 83.)

The continued forecasted growth in Inventories might be a natural function of the accounting structure rather than the result of a heuristic bias. For three years the levels of New Materials and Disbursements has been rising as has the Inventories Budget. If these materials were brought into the Stock Fund but not used right away by the customers then one would expect the levels of inventory to rise

accordingly. Unfortunately, data is not availableto ascertain the accuracy of the latest predicted rise in Inventories.

2. Budget Project 21 - Commissary and Ship Stores

Budget Project 21 includes foodstuffs and other consumable items which are stocked at Navy-owned commissary stores throughout the world. The commissary may be likened to supermarkets having three resale departments- groceries, meats, and produce. The manager of this Budget Project is responsible for over 3500 seperate items.

TABLE III

Budget Project- 21 Ratios

FY/ QTR	New Mat. Orders	Oblig.	Disburse.	Invent.
PHASE I				
81-1	0.98	1.00	0.98	0.99
2	0.98	0.94	0.96	0.99
3	0.99	1.00	0.97	0.99
4	0.98	1.00	1.01	0.97
82-1	1.00	1.00	1.00	1.00
2	0.99	0.99	1.00	1.00
3	0.98	1.07	0.98	1.01
4	1.03	1.04	1.03	1.00
83-1	0.98	0.97	0.97	0.99
2	1.03	1.04	1.04	1.00
3	1.00	1.00	1.00	0.99
4	1.02	1.01	1.06	0.99
PHASE II				
82-1	0.99	1.06	1.05	0.95
2	0.99	0.92	0.93	0.95
3	1.02	1.02	1.03	0.96
4	1.06	1.08	1.08	0.94
83-1	0.99	0.97	0.97	1.00
2	1.02	1.05	1.06	1.00
3	1.04	1.17	1.06	1.01
4	1.09	1.05	1.10	1.02

After examining this Budget Project, the existence of forecasting biases cannot readily be seen. Instead, is presented a set of uniquely stable data wherein the forecasts are surely based upon the predicted inflation rates almost exclusively. In all four categories Phase I data shows the ratio of forecast to budget (adjusted for inflation) to be quite close to 1.00. In addition, the forecasts are extremely close to the amounts budgeted in subsequent years.

In all four categories the budgets were within 10% of the previous forecasts and in most cases well within 5%. That this can happen in an environment in which product lines are constantly changing, where the number of potential customers continues to grow, where there is competition with the civilian community, and where managers may be using different inflation indexes than are used here may seem to be somewhat disconcerting. However, as explained by the Project Manager in his annual statement for FY-83, "Since the Current and past two years' sales have approximated the inflationary rates for those periods the commissary store sales increases for the next three fiscal years have been predicted at the expected inflation rates with no real sales growth anticipated." [Ref. 43]

Here, the behavioral heuristics discussed earlier can readily be appreciated. Given the fact that the past three years' worth of data have reflected growth rates almost equal to the inflationary rates existing during the periods, a very high probability has been assigned to the possibility of future developments following the same pattern. In this case it is evident that an "Anchor and Adjust" effect exists wherein the present budget is simply incrementally adjusted by the expected inflation rate in order to arrive at the forecast for the next year. However, the fact that Phase II analysis shows a remarkable rate of

accuracy in the forecasts vis-a-vis the resultant budgets, some of the dominant characteristics of the anchor and adjust effect as developed by Slovic and Lichtenstein [Ref. &scrusgd] are not present. Their analysis determined that biases resulting from an anchor and adjust effect typically caused insufficient adjustments which, in this case, should have forecasts to have been lower than the subsequent budgets and therefore, the Phase II ratios to be less than 1.00.

In this case, we have an adjustment factor that is provided to the manager from the outside--one which is, consequently, free of any bias on on his part. Thus we can see the anchor and adjust effect without the presence of some of the detrimental factors normally associated with it.

3. Budget Project 38 - Retail Fuels

Budget Project 38 includes the purchase and usage of bulk fuel and related items in support of U. S. Navy requirements. The manager of this Project is responsible for 64 different line items.

Once again, within this Budget Project the forecasting method appears to be extremely close to a simple adjustment for inflation. In each of the four categories over the course of three years the adjusted ratio of forecast to budget (phase I) was essentially 1.00 (with the exception of Inventories which was approximately 1.15 for FY81-82). This, of course, may well indicate another project that is very stable (i.e., there is no real growth) and in which the manager expects that the Project will just keep up with inflation.

What is different about Budget Project 38, however, is that Phase II analysis indicates that the accuracy of the forecasting is not nearly as good as Budget 21. In FY 82 the budget came in very slightly above forecasted levels in

TABLE IV

Budget Project- 38 Ratios

FY/ QTR	New Mat. Orders	Oblig.	Disburse.	Invent.
PHASE I				
81-1	0.99	0.99	1.01	1.14
2	1.07	1.03	1.06	1.15
3	0.95	0.95	1.01	1.16
4	1.00	1.04	0.98	1.16
82-1	1.05	1.00	1.00	1.00
2	0.99	1.04	0.98	1.00
3	0.98	0.96	0.96	1.00
4	1.01	0.99	0.99	1.00
83-1	1.03	1.00	0.93	0.93
2	1.07	1.00	1.00	1.00
3	0.95	1.04	1.04	1.00
4	0.96	0.99	0.99	1.00
PHASE II				
82-1	1.02	0.97	0.95	0.97
2	0.96	1.01	0.97	0.98
3	0.96	0.93	0.98	0.98
4	1.02	1.01	1.03	0.98
83-1	1.12	1.09	1.02	1.11
2	1.21	1.14	1.07	1.18
3	1.03	1.09	1.09	1.19
4	1.01	1.07	1.07	1.20

all four categories but in 1983 the previously forecasted levels were all above the approved budget with Inventories as much as 17% high. This indicates that there are forces at work within the fuels area (such as a reduction of the price of fuel) which have not been addressed in the forecasts. It becomes apparent then that continued reliance on such an approach to forecasting for this budget project has led to forecasting inaccuracies as reflected in Phase II analysis. This has led to a situation in which a prediction of no real growth has been made when actually a shrinkage of the level of activity has occurred for the budget project. In the face of this, continued forecasting methods based solely upon predicted inflation rates may very well disguise

the actual dynamics of the budget project and lead to further inaccuracies in the future.

4. Budget Project 81 - Depot Level Repairables

This budget project is unique in that it has only been in existence since 1 April, 1981 as part of a three year test program concerning the financing of the repair of certain material elements of naval systems and subsystems. The project controls line items within the following spectrum:

1. Shipboard hull, mechanical and electrical spares and repair parts;
2. Gun and guided missile fire control and launching systems and surface radar repair parts;
3. Surface to air guided missile repair parts;
4. Surface and underwater ordnance repair parts;
5. Electronic repair parts; and
6. Aviation repair parts.

Unfortunately, because of the short life of Budget Project 81, less data are available than for the previous budget projects. This hampers the analysis to some degree. What is readily apparent, however, is the difficulty inherent in making accurate forecasts in the early life of an organization. In Phase I analysis, growth is predicted in all four categories but there appears to be no correlation among the categories in the first year of the program. In New Material Orders alone the predicted growth rate for FY82-83 changes from 85% to 419% in two quarters. Forecasts in the second year continue to predict growth but in this instance the predicted levels for each category are more in line with one another and quarterly forecasts appear to be more stable while still predicting a 30% growth rate.

Phase II analysis is quite limited because of the lack of data. It can be seen though that forecasts for FY

TABLE V

Budget Project - 81 Ratios

FY/ QTR	New Mat. Orders	Oblig.	Disburse.	Invent.
PHASE I				
82-1	1.81	1.64	4.83	1.03
2	0.86	1.17	3.80	1.04
3	1.31	1.00	1.43	1.05
4	4.19	1.25	1.66	1.05
83-1	1.34	1.54	1.38	1.12
2	1.29	1.46	1.36	1.17
3	1.31	1.41	1.28	1.21
4	1.31	1.39	1.19	1.25
PHASE II				
83-1	1.24	1.01	1.19	0.85
2	1.28	0.88	1.18	0.85
3	1.31	1.01	1.10	0.85
4	1.31	1.10	1.02	0.85

83 were well above the subsequently approved budget in all four categories except Inventories where the forecast was only 85% of the approved budget. Once again, the data are unstable and the degree of accuracy of the forecasts even in the second year is marginal and differs for each category. The over estimation of these three categories, New Material Orders, Obligations, and Disbursements might point to an aspiration level effect but this phenomenom is unsupported by Inventories (although Phase I analysis does, indeed, predict a real growth rate of 20% for Inventories which later turned out to be actually more like 35%).

C. CONCLUSIONS

As can be seen from examining the different budget projects, predicting future growth for the entire Navy Stock Fund is a monumental task frought with many opportunities

for the introduction of subjective biases. Analyzing just half of the eight budget projects has exposed the possible presence of a number of behavioral biases affecting the final outcome of a budgetary forecast and ultimately reducing the accuracy of that forecast. In Budget Project 14 the manager is seen forecasting rapid growth based upon the information that the previous forecast was below the authorized budget only to see the subsequent budget come in well below his inflated forecast.

In the next budget project (21), a well established stable program, the manager's forecasts are based solely upon one parameter (inflation) and surprisingly enough, these forecasts have proven to be quite accurate. This accuracy is maintained for eight consecutive quarters which lends creditability to such forecasting methods in this particular case. However, in the next budget project (38) which is just as established as the previous one, the identical process of forecasting introduced biases into the process. Lastly, is introduced a very new budget project whose forecasts bring out quite clearly just how unstable a decision maker's predictions can become in the face of a high degree of uncertainty. Here, very optimistic predictions are the rule. Not having any historical base upon which to establish any prior probabilities at all can certainly contribute to the problems decision makers face in making accurate, meaningful forecasts of future growth.

All of these budget projects - with the notable exception of Budget Project 21 - have experienced inaccuracies in the forecasting of future budgets. The tendency has been for the error to be on the high side - that is, forecasted growth was higher than subsequent actual budgetary growth. This was not the case in FY 82 for Budget Project 14 but in the following year the budget was over-forecast by an average of 6%. Budget Project 38 was over-forecast by an

average of 5% and Budget Project 81 by an average of 6.5%. In each case, predictions were subject to different biases which contributed to the overall inaccuracies of forecasting of the budgets of the four major budget projects which make up the Navy Stock Fund.

IV. A CORPORATION

A. BACKGROUND

The second section of the analysis is related to a firm within the private sector. As before, forecasts are examined along with the corrections to the forecasts to determine what patterns if any, exist.

The data used in this chapter have been provided by a large industrial corporation in the northeastern United States which is a high technology manufacturer of specialty steel and related products. It is organized into three groups which operate, for the most part, as independent production, sales and profit centers. The data used here were collected from one of the groups which is referred to as "Corporation A". It is a wholly owned subsidiary which manufactures specialty steel products.

Corporation A produces many forecasts, two of which are studied here. Annually, Profit Plans are completed in December for the following year. The Profit Plans are business plans which include both managerial plans and financial/operating forecasts. Many of the operating forecasts are divided into monthly targets. These numbers are both forecasts and objectives. They are supposed to be realistic but are also used to judge performance.

The Profit Plans are critical documents in the corporate planning process and, as such, evolve from a process which involves operating managers, senior management at Corporation A and the parent company all interacting in a structured planning process.

Each month, reports are made to the corporate offices stating performance compared to the Profit Plan targets and

providing forecasts of outputs for the subsequent months. The two forecasts analyzed here are the monthly forecasts from the Profit Plan (PP) and the One-Month-Ahead- Update from the monthly reports (MU).

B. ANALYSIS STRUCTURE

The data used are forecasts of Tonnage Shipped and Sales for each month over the four year period from January 1975 through December 1978. As in the previous chapter these categories are treated independently. These particular items were chosen because they are not strongly correlated. There was an average backlog of three months or more for orders during the period studied which made Sales and Shipments independent forecasts for any given month.

The data in Table VI and VII consist of the Profit Plan, One-Month-Ahead Update, the Actual Results and the differences between the forecasts and actual results. Table VI lists the data month by month while Table VII compiles these numbers into yearly averages for Tonnage Shipped. The sign of the difference is important. A difference with a positive sign indicates that the PP or MU exceeded the actual results, whereas a difference with a negative sign means that the actual totals were greater than the respective plan. Tables VIII and IX accomplish the same task for Sales.

1. Tonnage Shipped

Looking at the actual column of Table VI one observes that the amount of steel shipped goes through three phases. Throughout 1975 and into 1976 the shipments decrease. In 1976 there is no real stability but a floor is reached in July and shipments begin to increase after that point. The final period is marked by growth (with a few exceptions) throughout 1977 and 1978.

As Table VI shows the actual shipments in 1975 were well below the expectations of the Profit Plan. The Profit Plan predicted a stable year with a decline of about 5% in shipments in the second half of the year compared to the first half. As the actual results came in under the Profit Plan, the Monthly Updates tended during the first quarter to under estimate the amount of the decline. This tendency was reversed during the final three quarters as the Monthly Updates were consistently correcting the Profit Plan with a revised forecast that overstated the actual amount of shrinkage. Not only did the pattern change but the magnitude of the difference between the actual results and the Monthly Update was greater in the direction of overstating the decline. That is, as things continued to get worse management chose to update the Profit Plan conservatively predicting greater shortfalls than actually occurred in each of the last five months of 1975.

This continued into 1976. The Profit Plan predicted that the decline in shipments would bottom out in May and then gradually increase. In fact, shipments were sluggish over the first seven months of 1976. Then in August shipments began to increase, a trend which continued until December. Although the Profit Plan had predicted this type of occurrence it predicted higher shipments than were actually made.

The pattern of over correction in the Monthly Update continued during the first two months of 1976 and the magnitude of the over correction continued to increase as well. Then in March shipments suddenly increased. The Monthly Update while predicting an increase to 26800 tons over February's actual shipments of 22729 tons was still short of the Profit Plan forecast of 28400 tons. Actual shipments of 29987 tons were achieved. Thus, in this instance, the Profit Plan was updated in the wrong direction. In April as actual

TABLE VI

Tonnage Shipped by Month (in tons)

MTH	PROFIT PLAN	MONTHLY UPDATE	ACTUAL	DIFF (PP-A)	DIFF (MU-A)
1975					
JAN	31800	31800	31049	751	751
FEB	32250	29000	26143	6107	2857
MAR	32750	29000	28261	4489	739
APR	32500	28257	28326	4174	-69
MAY	32250	25338	24886	7364	452
JUN	30750	20000	20669	10081	-669
JUL	29800	20000	19756	10044	244
AUG	29400	20800	22719	6681	-1919
SEP	30600	25000	25987	4613	-987
OCT	31500	23000	24798	6702	-1798
NOV	31800	20500	21524	10276	-1024
DEC	29000	18000	19904	9096	-1904
1976					
JAN	25500	21500	22766	2734	-1266
FEB	26000	21000	22729	3271	-1729
MAR	28400	26800	29987	-1587	-3187
APR	31800	25000	22462	9338	2538
MAY	23500	23500	23016	484	484
JUN	26200	26500	27686	-1486	-1186
JUL	25900	23500	20546	5354	2954
AUG	28500	27000	25660	2840	1340
SEP	31800	25500	26084	5716	-584
OCT	29900	26000	25491	4409	509
NOV	29500	27000	29879	-379	-2879
DEC	26000	23000	23441	2559	-441
1977					
JAN	20400	22600	19622	778	2978
FEB	19900	27500	25502	-5602	1998
MAR	23100	31000	31489	-8389	-489
APR	21500	29400	26521	-5021	2879
MAY	23200	28500	27482	-4282	1018
JUN	23800	29200	27830	-4030	1370
JUL	21700	22000	20022	1678	1978
AUG	21200	30000	30058	-8858	-58
SEP	19900	29000	27599	-7699	1401
OCT	20300	30000	30992	-10692	-992
NOV	20000	30000	31718	-11718	-1718
DEC	21800	27200	28783	-6983	-1583
1978					
JAN	31490	31500	29241	2249	2259
FEB	29680	30000	28883	797	1117
MAR	32880	32000	33706	-826	-1706
APR	30660	30000	30978	-318	-978
MAY	32560	35300	37056	-4496	-1756
JUN	30510	35000	33775	-3265	1225
JUL	24720	28000	28793	-4073	-793
AUG	31400	33500	34593	-3193	-1093
SEP	29500	34000	31635	-2135	2365
OCT	30520	34000	34840	-4320	-840
NOV	28290	34500	32406	-4116	2094
DEC	27200	31500	30861	-3661	639

shipments dropped the Monthly Update remained high and for the first time in eight months the Monthly Update forecasted results that were greater than actual shipments.

In June and July the same sort of thing happened. In June shipments increased again to 27686 tons. The Profit Plan prediction of 26200 tons was slightly increased to 26500 tons by the Monthly Update, an adjustment which was too small. In July as shipments dropped markedly from 27686 tons to 20546 tons, the Monthly Update brought the Profit Plan down from 25900 tons to 23500 tons which was almost 3000 tons short of the actual shrinkage. Thus in periods of instability, that is, when there is no clear trend controlling actual shipments there appears to be a monthly pattern wherein the Profit Plan also influences the Monthly Update which may cause a tendency toward under correction.

In August the shippage rate rose over JUly's low and this increase was stable over the next two months. The Monthly Update continued to under correct the Profit Plan in August, and in the stable months of September and October the Monthly Update predicted actual shipments almost exactly. Then in November another rise in shipments occurred and once again the Profit Plan was updated in the wrong direction by the monthly forecast.

After a relatively inactive January in which only 19622 tons were shipped, shipments in 1977 were much higher than in previous years. The Profit Plan did not predict this as it was below the actual results in ten of the twelve months of the year. As was true in 1976, when faced with instability the forecasters had difficulty predicting accurately. In January of 1977 as shipments fell the Monthly Update predicted a rise of the Profit Plan from 20400 to 22600 tons.

As shipments continued to grow with some stability over the course of the year another pattern developed in the

relationship between the Profit Plan and the Monthly Updates. As was previously mentioned, the Profit Plan was low in throughout most of the year. The updated forecasts, on the other hand, were quite close to actual shipments as the updated forecasts were within 5% of actual results in six of the months. What is notable though is that when the updates were in error they tended to be so on the high side, that is, the update adjusted the Profit Plan to a number that was above actual shipments. Once again, in the face of instability inaccuracies were introduced. In July, for example, shipments dropped way down to 20022 tons. The Profit Plan, however, was corrected up from 21700 tons to 22000 tons.

Over 1978 shipments continued to grow and reached their highest point of the period. The Profit Plan predicted this growth to some degree as the forecasts called for considerably greater shipments than was forecasted for 1977. In ten of the twelve months, however these projections were under the actual results. Thus, while growth was clearly forecast the amount of growth was understated by 7% as shown in Table VII.

During the first four months of 1978 the One-Month-Ahead Update made adjustments to the Profit Plan which were all in the wrong direction. The actual results were below the Profit Plan forecasts in January and February and above them in March and April. However, in each instance, the Monthly Adjusted the Profit Plan away from the actual shipments. It should be noted that in three of the four months the Profit Plan was extremely close to the actual results before it was adjusted inaccurately.

Over the last eight months the Profit Plan was consistently under actual shipments. The updated plans became quite accurate and with the exception of the months of September and November they predicted within 5% accuracy

the actual shipments for the remainder of 1978. However, there was a pattern developed during these months, which was if there were an inaccuracy it was from an overestimate of what the actual shipments were going to be. In September and November the Profit Plan under estimated actual amounts by 2135 and 4116 tons respectively while the updated plans, on the other hand, over estimated these same results by 2365 and 2094 tons.

TABLE VII

Average Tonnage Shipped (in tons)

YEAR	PP	ACTUAL	DIFF.	PERCENT DIFF.
1975	31200	24502	6698	27.3
1976	27750	24979	2771	9
1977	21400	27302	-5902	-21.6
1978	29951	32231	-2280	-7
Four Yr. Avg.	27575	27253	322	1.2

YEAR	CPP	ACTUAL	DIFF.	PERCENT DIFF.
1975	24225	24502	-277	-1.1
1976	24692	24979	-287	-1.1
1977	28033	27302	731	2.7
1978	32442	32231	211	0.7
Four Yr. Avg.	27348	27253	95	0.3

As was noted earlier the Profit Plans are important targets which management at all levels strives to achieve. Table VII demonstrates just how inaccurate even the most meticulously compiled plans may become in the face of environmental instability. Table VIII shows a 1977 Plan that predicted further shrinkage from the 1975 and 1976 plans when the amount of material shipped rose significantly

causing the yearly plan to be below actual outcomes by over 21%. Additionally, in the improving times such as 1978 when shipments were steadily rising, the average forecast of the Profit Plan while predicting growth, understated that growth by 7%.

When considering the One-Month-Ahead updated plans it appears that Corporation A is making the most out of available information. When these forecasts have been in error they have presented definite trends which provide useful information concerning predictive biases. For example, in 1978 when shipments were growing, there was a clear pattern of predicting more growth than actually occurred. It would appear that line managers were setting high targets at the beginning of each month when things were going well. On the other hand, when things were going poorly (as concerns amount of material shipped) the pattern was one of overstating the degree by which actual results would fall short of the Profit Plan.

One other matter of note is the degree of accuracy of the monthly updates. Even in the face of instability such as in 1976 and 1977 the average error of these forecasts was, indeed, small as shown by Table VII.

On average, the Monthly Update is quite close to the actual outcomes. In examining the Profit Plan itself, though, some of the theory presented in the literature is illustrated. Between 1975 and 1976 the actual amount of tonnage shipped increased by only 2% and the 1976 Profit Plan was adjusted down from 1975 to reflect this lack of growth. However, the 1976 forecast was not adjusted sufficiently, and the forecast remained significantly above actual results.

In 1977, the Profit Plan really missed the mark. While the Profit Plan predicted a further decline in shipments (by about 17% below 1976) the actual number of tons

shipped increased by 9.3%. It appears that there was a tendency to remain pessimistic even in the face of steadily increasing figures over the last half of 1976.

For 1978 the Profit Plan predicted increased shipments. Once more, however, the forecast was short of what actually hapened. Here, as well as in 1975 and 1976 there appears to by an Anchor and Adjust heuristic in effect. In these periods, the Profit Plan forecasted accurately what direction the amount of shippage was taking but the yearly adjustments were consistently short in each year.

2. Sales

Sales are presented in terms of thousands of dollars ($ x 1000). As Table VIII shows sales fell well below the Profit Plan in 1975. This trend continued into the first seven months of 1976 and the recovery in sales did not begin until August of that year.

The Profit Plan for 1975 predicted sales of between $14000 and $16000 over the course of the year. However, this was an off year for steel and actual sales declined steadily throughout the year. The monthly updates did not predict the severity of the decline until March. During April and May the monthly updates did not adjust the Profit Plan all the way down to actual levels but they were, indeed, close. Beginning in June and continuing through the year until December the monthly predictions gave projections which were consistently more severe than the actual decline in sales.

The sales slowdown went on into 1976 but the 1976 Profit Plan while lower than the 1975 Plan was still forecasting sales well above actual levels. The monthly updates for the most part, continued along the same pattern as 1975. However, in March sales suddenly jumped from $9306 in February to $12494. The Monthly Update predicted that sales

TABLE VIII

Monthly Sales (x $1000)

Month	PROFIT PLAN	MONTHLY UPDATE	ACTUAL	DIFF. (PP-A)	DIFF. (MU-A)
1975					
JAN	14413	14413	14885	-472	-472
FEB	14668	12919	11888	2780	1031
MAR	14956	13094	12602	2354	492
APR	15537	12240	12158	3379	82
MAY	15470	10883	10505	4965	378
JUN	14732	8578	8924	5808	-346
JUL	14650	8512	8629	6021	-117
AUG	14508	9020	9417	5091	-397
SEP	15147	10396	10459	4688	-63
OCT	15754	9663	10132	5622	-469
NOV	15885	8873	9135	6750	-262
DEC	14546	7725	8529	6017	-804
1976					
JAN	11459	8868	9428	2031	-560
FEB	11781	8814	9306	2475	-492
MAR	12839	11409	12494	345	-1085
APR	15007	10783	9703	5304	1080
MAY	15418	9776	9740	5678	36
JUN	12271	10779	12010	261	-1231
JUL	12451	9695	9513	2938	182
AUG	13247	11074	11803	1444	-729
SEP	15669	11825	12077	3592	-252
OCT	14612	12130	11975	2637	155
NOV	14508	13001	14047	461	-1046
DEC	12546	11032	11318	1228	-286
1977					
JAN	13821	11273	9698	4123	1575
FEB	13353	13317	12174	1179	1143
MAR	15303	14872	15161	142	-289
APR	14870	14304	13157	1713	1147
MAY	15380	14423	13985	1395	438
JUN	15548	15135	14373	1175	762
JUL	13515	11874	10732	2783	1142
AUG	14861	15749	16826	-1965	-1077
SEP	14612	15680	14838	-226	842
OCT	15490	15944	16393	-903	-449
NOV	14741	15956	16727	-1986	-771
DEC	15574	14414	15050	524	-636
1978					
JAN	16729	16717	15411	+1318	1306
FEB	15755	16216	15982	- 227	234
MAR	18139	18101	19185	-1046	-1084
APR	16914	17119	17360	- 446	-241
MAY	17949	19691	20594	-2645	-903
JUN	16874	18595	18948	-2074	-353
JUL	13772	15937	16474	-2702	-537
AUG	17291	18849	19804	-2513	-955
SEP	16720	19778	18318	-1598	1460
OCT	17289	19697	20231	-2942	-534
NOV	16016	19962	18378	-2362	1584
DEC	15342	18530	18394	-3052	136

would increase (up to $11409 from $8814) but the adjustment remained low. During the next month sales once again fell off and the updated projection, while predicting such an occurrence, made an adjustment to the Profit Plan which was still short of the actual decline in sales. An almost identical situation occurred in June when sales again jumped to $12010.

From August through December sales rose but remained below the levels forecasted in the Profit Plan. The One-Month-Ahead Plans for these months were for the most part fairly accurate. In the Month of November sales peaked at $14861 and in this instance the monthly forecast was considerably short predicting sales of $13001.

After a slow January, Sales began to pick up in 1977 and were greatly accelerated over the last five months of the year. The Profit Plan for 1977 predicted such growth but in eight of the twelve months the Plan remained above actual sales. The monthly plans were rather inaccurate in the months of January, February, July, and August. In the first two months sales were down from the recovery realized in the last part of 1976 and this fact was not predicted closely in the monthly plans. Then sales recovered in March- a fact which was reflected in the Monthly Update in that month. Sales fell in April but the Monthly Update did not predict this and the April forecast was too high. As Sales began to grow in the summer the accuracy of the updated plans improved.

1978 was a record year for Sales at Corporation A. The Profit Plan forecasted increases over 1977 but in eleven months the Plan was below actual results. The Monthly Updates missed the mark in January, March, September and November but were extremely accurate in predicting Sales in the other months. In January just as had happened in past years Sales fell from the closing highs of the last half of

1977. The monthly adjustment made almost no change to the Profit Plan and the result was an inaccurate prediction. In March, Sales climbed to $19185 but the Monthly Update adjusted the Profit in the other direction while predicting Sales of $18101. Both of the major inaccuracies at the end of the year were the result of the Monthly Update forecasting Sales far above the provisions of the Profit Plan. Actual Sales were significantly greater than the Profit Plan in both instances but did reach the levels predicted in the monthly plans.

The deleterious effect of environmental instability can be seen in sales forecasts just as in shipments. It seemed that each January sales activtiy would drop off from the rather comfortable levels of the end of the previous year and that each March sale would peak for some reason only to fall back to previous levels in April. In all four years this occurrence adversely effected the accuracy of the latest forecast. Another phenomena which concerns the updated forecasts is that the monthly inaccuracies described above tended to cancel each other out and on average, as demonstrated in Table IX, the One-Month-Ahead Plans were extremely accurate.

During 1975-1976 (just as was true with shipments) the Profit Plan forecasted higher sales than actually occurred. In 1977 the Profit Plan predicted a growth in sales over 1976 levels and this forecast, while high, was within 4.7% of actual sales. In 1978 continued sales growth was forecast but this time the forecast lagged actual sales growth by 9.3%.

It also appears that an Anchor and Adjust effect is at work here. The Profit Plan was adjusted in the correct direction each year and the amount adjusted consistently (except for 1977) tended to fall short of actual sales.

TABLE IX

Average Sales (x $1000)

YEAR	PP	ACTUAL	DIFF.	PERCENT DIFF.
1975	15022	10605	+4417	+41.6
1976	13484	11118	+2366	+21.3
1977	14756	14093	663	4.7
1978	16566	18257	-1691	-9.3
Four Yr. Avg.	14957	13518	1439	10.6

YEAR	CPP	ACTUAL	DIFF.	PERCENT DIFF.
1975	10526	10605	-79	-0.7
1976	10766	11118	-352	-3.2
1977	14412	14093	319	2.3
1978	18266	18257	9	0.0
Four Yr. Avg.	13492	13518	-26	-0.2

As was true concerning shipments the One-Month-Ahead Plan reflects an extremely slight tendency for the forecaster to over adjust. As shown by Table IX, the percentage differences while almost negligible are all indicative of an over correction to the Profit Plan.

3. Conclusions

In both categories--Sales and Tonnage Shipped--the presence of the Anchor and Adjust effect seems to exist as the Profit Plan is adjusted from year to year. In the 1977 forecast of shipments, the Profit Plan was adjusted in the wrong direction and, consequently, completely missed what actually transpired.

The presence of Anchor and Adjustment can be indicated when two criteria are satisified, although more complex formulations of the process are possible. Firstly, the direction of the adjustment to the forecast must be in

the in the correct direction. For example, the Monthly Update must adjust the Profit Plan in the same direction that actual results are taking in relation to the Profit Plan. This indicates the forecaster has information in addition to past forecasts and such information has some usefulness in predicting the future. Secondly, the magnitude of the correction must be less than the magnitude of the actual results. That is, the forecaster is anchored and doesn't adjust far enough. To test for anchoring and adjustment, the Monthly Updates in Tables VI and VIII which met the first stipulation were identified. The forecast for that month (Forecast for month t+1) was subtracted from the actual for that month (month t). The actual for the subsequent month (t+1) was subtracted from the actual of the reference month (month t). The absolute values of both resultants were then compared. If the Anchor and Adjustment heuristic is clearly dominant the first resultant should be less than the second resultant. That is, the difference between current and forecast values will be less than the difference between current and future actual outcomes. When the test was done it was found that it held 50% of the time for shipments and 54% of the time for sales. Thus, they over-adjust just as often as they under adjust which is not consistent with simple anchoring and adjustment.

V. FINDINGS

This thesis investigates the ways in which man makes decisions in an organizational environment. This was done in an attempt to discover aids that might contribute to better decision making. A review of current literature in the area of decision theory revealed two interesting facts. First, researchers in the field of decision theory led by Tversky and Kahneman argue that people rely on a limited number of heuristic principles that reduce the complex tasks of assessing subjective probabilities and predicting values to simpler judgmental operations. Tversky and Kahneman identify "representativeness," "availability," and "anchoring and adjustment" as the three most common principles which decision makers employ in the course of conducting business. The second finding is that research in the field of decision theory has been conducted largely in the area of individuals. No quantitative data could be found indicating a dependence on heuristic principles by decision makers in an organizational structure. If as Tversky and Kahneman postulate, reliance on heuristics can lead to substantial biases, and this can be shown using corporate data, then such biases can be corrected resulting in better decisions.

This thesis analysed organizational forecasts to to see if the basic theory held. Budget forecasts were used as the focus of the investigation because they are critical to the success of any organization and therefore should be well thought out. Both the Navy Stock Fund (an accounting entity of a large government organization) and an operating division of a private sector corporation were analysed separately to see what similarities and differences could be

found. In the stock fund, the analysis had two major elements. First, future year budget forecasts and current year approved budgets were contrasted to determine if patterns other than inflation could be identified. If patterns could be found and analyzed then better forecasts might be achieved. Secondly, the accuracy of individual forecasts was checked by comparing future forecasts with the subsequent approved budgets. This would not only point out possible differences in individual manager's forecasting techniques and accuracy, but a study of the direction in which the forecast was off would provide insight into the application of heuristic principles in an organizational structure.

With respect to the Navy Stock Fund, no decisive patterns were found to exist across all budget projects. Examples of the existence of biases associated with reliance on heuristic principles in decision making can be shown in individual budget projects. It appeared, however, that accuracy of the forecasts was determined more by the stability of the budget project by than behavioral biases. The data show the more stable budget projects (21 and 38) have more accurate forecasts than than the less stable ones (14 and 81). The most stable project (21) had almost no evidence of forecasting bias. There was, however, some evidence of anchor and adjustment, representativeness, and aspiration level present in the forecasts of the less stable projects. Additionally, political pressures have a significant effect on forecasts within the Navy Stock Fund making it difficult to improve on the current method for making forecasts. Understanding the possible biases associated with reliance on heuristics in decision making might help the individual manager make better predictions, but organizational pressures coupled with the tendency to aggregate data and therefore obscure possible patterns reduces their

usefulness. In other words, the psychological patterns discussed in the literature may be present at the individual level but are overcome by the organizational structure of the Navy Stock Fund.

The data analyzed from Corporation A were different in form from that of the Navy Stock Fund, but performed essentially the same purpose and revealed essentially the same results. Corporation A prepares an annual Profit Plan in December for the following year and updates it throughout the year using a One-Month-Ahead update. These forecasts were compared to actual totals for a given time period to see if the biases associated with heuristic principles were apparent. Examples of the effect of anchor and adjustment can be seen in several instances but the data did not support any conclusions that are applicable across the board. Trends such as conservatism in forecasting resulting in under correction are apparent under certain circumstances but not in others. When things were going poorly, predictions tended to overstate the problem however, when things were going well, forecasts exceeded actual results. When aggregated, the monthly inaccuracies tended to cancel each other out and averages of the One-Month-Ahead plans were extremely accurate.

As pointed out in the individual analysis in Chapters III and IV there are instances where the effects of the theory can be seen. There are an equal number of situations however, where no such correlation can be shown. The tendency for operational managers to be pessimistic when things are going badly and overly optimistic when things are going well can be shown but not with enough frequency to make it a useable predictive tool.

Overall, this research has broken new ground in combining behavioral decision theory and organizational forecasting. As a first cut, conclusive results were not

visible. The data do show however, that reliance on the simple minded technique of anchoring and adjustment is not justified. Future research should attempt to obtain larger data sets and begin to look for more context dependent biases. For example, looking for different effects in periods of growth than in periods of decline, or differances effected by the stability of the industry. The area of biases in organizational forecasting is critical and needs further research.

APPENDIX A

NAVY STOCK FUND RAW DATA

TABLE X

Budget Project 14 ($ x 1000)

	NEW MATERIAL ORDERS		OBLIGATIONS	
YEAR/ QTR	BUDGET	FORECAST	BUDGET	FORECAST
1981/1	74780.	89723.	86229.	85405.
/2	72050.	72072.	86286.	181680.
/3	71438.	93574.	111126.	163210.
/4	86130.	89991.	112543.	162105.
1982/1	97569.	116787.	98240.	85405.
/2	99254.	131687.	208945.	181680.
/3	99045.	131431.	182289.	163210.
/4	114943.	151036.	173626.	162105.
1983/1	103900.	128200.	158850.	208400.
/2	102100.	119000.	148250.	188500.
/3	117600.	137200.	192950.	235500.
/4	109132.	127328.	189450.	233800.

	DISBURSEMENTS		INVENTORIES	
YEAR/ QTR	BUDGET	FORECAST	BUDGET	FORECAST
1981/1	55814.	62907.	753618.	930649.
/2	105116.	57611.	799914.	932719.
/3	94413.	168401.	846938.	968796.
/4	92257.	103981.	892503.	1045089.
1982/1	98505.	134068.	1238270.	1485035.
/2	111936.	152350.	1295840.	1559095.
/3	129856.	176726.	1353458.	1633157.
/4	107450.	146256.	1410976.	1707217.
1983/1	127000.	150800.	1269681.	1660600.
/2	145100.	171400.	1369681.	1760000.
/3	167900.	198900.	1469681.	1860000.
/4	139000.	164500.	1560601.	1963165.

TABLE XI

Budget Project 38 ($ x 1000)

YEAR/ QTR	NEW MATERIAL ORDERS		OBLIGATIONS	
	BUDGET	FORECAST	BUDGET	FORECAST
1981/1	615200.	676300.	549300.	600700.
/2	592400.	621700.	549300.	626100.
/3	524100.	621500.	595100.	625800.
/4	546800.	596500.	595100.	681100.
1982/1	659900.	712200.	619500.	661100.
/2	649800.	684700.	619400.	688700.
/3	644600.	684800.	671100.	688600.
/4	583800.	657400.	671100.	708700.
1983/1	704600.	718200.	606100.	639800.
/2	661900.	665000.	606000.	639800.
/3	563700.	638400.	631100.	693200.
/4	586400.	638400.	661000.	693100.

YEAR/ QTR	DISBURSEMENTS		INVENTORIES	
	BUDGET	FORECAST	BUDGET	FORECAST
1981/1	516700.	577600.	363126.	457179.
/2	516700.	602700.	364897.	464494.
/3	584200.	652900.	365251.	466816.
/4	629000.	678000.	365743.	467591.
1982/1	611517.	655950.	471496.	507216.
/2	620038.	648311.	473853.	508484.
/3	664799.	686928.	475038.	509755.
/4	660346.	704011.	476259.	510274.
1983/1	643702.	635333.	454406.	448092.
/2	606624.	640440.	427340.	450332.
/3	628044.	686685.	427047.	450882.
/4	655530.	688542.	426754.	451513.

TABLE XII

Budget Project 21 ($ x 1000)

YEAR/ QTR	NEW MATERIAL ORDERS BUDGET	FORECAST	OBLIGATIONS BUDGET	FORECAST
1981/1	178000.	193000.	170000.	187000.
/2	170000.	183000.	175000.	182000.
/3	182000.	199000.	183000.	202000.
/4	194600.	211300.	195451.	214864.
1982/1	195000.	208000.	177000.	190000.
/2	185000.	197000.	198000.	210000.
/3	195000.	205000.	198000.	228000.
/4	199300.	220900.	198086.	220108.
1983/1	210000.	218000.	195000.	200000.
/2	193000.	210000.	200000.	220000.
/3	197000.	207000.	195000.	205000.
/4	201800.	216500.	209400.	223500.

YEAR/ QTR	DISBURSEMENTS BUDGET	FORECAST	INVENTORIES BUDGET	FORECAST
1981/1	172000.	187000.	75236.	82036.
/2	172000.	182000.	76236.	83236.
/3	188000.	202000.	78236.	85236.
/4	193451.	214864.	79878.	85778.
1982/1	179000.	192000.	86500.	92500.
/2	196000.	210000.	87500.	94000.
/3	197000.	206000.	89000.	96000.
/4	199086.	220108.	91126.	97526.
1983/1	197000.	202000.	92500.	97000.
/2	198000.	218000.	94000.	99000.
/3	195000.	205000.	95000.	99500.
/4	200400.	223500.	96000.	100400.

TABLE XIII

Budget Project 81 ($ x 1000)

YEAR/ QTR	NEW MATERIAL ORDERS BUDGET	NEW MATERIAL ORDERS FORECAST	OBLIGATIONS BUDGET	OBLIGATIONS FORECAST
1982/1	96900.	187807.	163326.	286425.
/2	171234.	157657.	227554.	286425.
/3	171234.	241180.	284210.	305175.
/4	53730.	241179.	227554.	305175.
1983/1	151140.	213999.	282296.	458626.
/2	122738.	169207.	326500.	504166.
/3	184107.	253812.	301957.	449279.
/4	184107.	253812.	277914.	406758.

YEAR/ QTR	DISBURSEMENTS BUDGET	DISBURSEMENTS FORECAST	INVENTORIES BUDGET	INVENTORIES FORECAST
1982/1	45466.	235525.	2308195.	2555962.
/2	57884.	235525.	2363867.	2636861.
/3	153430.	235525.	2419540.	2717760.
/4	132090.	235525.	2475063.	2798659.
1983/1	197821.	288750.	3000515.	3552445.
/2	200425.	288750.	3096072.	3817703.
/3	213899.	288750.	3191629.	4082961.
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